FAA-E-2590a
November 23, 1977
SUPERSEDING
FAA-E-2590, 1/15/75

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

CLOUD HEIGHT INDICATOR SYSTEM

1. SCOPE AND CLASSIFICATION

1.1 Scope.- The cloud height indicator (CHI) system specified herein will measure cloud height and provide digitized data to remote units which indicate cloud height in feet or meters. This data is used for pilot information during performance of National Airspace System Traffic Control. This equipment will automatically perform data generation, data conversion, transmission, and display. This eliminates the necessity for an observer to read cloud height from a chart or to estimate cloud height and then transmit to ATC personnel either verbally or in writing the value thus obtained.

1.2 Classification.- The CHI system covered by this specification will be of one type and size consisting of a laser, detector, analog to digital converter, transmission system and digital readout display with accuracies as specified in the following paragraphs.

1.2.1 System.- The CHI and its display system will consist of:

(a) Transceiver unit (3.1.2)
(b) Maintenance unit (3.1.3)
(c) Digital display units (3.1.4)

2. APPLICABLE DOCUMENTS

2.1 General.- The following specifications and standards, of the issues in effect at the time of the invitation for bids or request for proposals form a part of this specification and are applicable to the extent specified herein.

2.1.1 FAA Specifications.-

FAA-E-163	Rack, Cabinet and Open Frame Types
FAA-G-2100/1	Part I, Electronic Equipment, General Requirements; Basic Requirements for all Equipments
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semi-Conductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Microelectronic Devices
FAA-G-2300	Panel and Vertical Chassis Rack
FAA-D-2494/1	Technical Instruction Book Manuscripts: Electronic Equipment, Requirements For
FAA-D-2494/2	Preparation of Reproducible (Camera Ready) Copy

2.1.2 FAA Standards.-

FAA-STD-013	Quality Control Program Requirements

2.1.3 Military Specification and Standards.-

MIL-E-17555	Electronic and Electrical Equipment and Associated Repair parts; Preparation and Delivery of
MIL-STD-470	Maintainability Program Requirements for Systems and Equipment
MIL-STD-471	Maintainability Demonstration
MIL-STD-781	Reliability Test Exponential Distribution

MIL-STD-785A	Reliability Program for Systems and Equipment
MIL-STD-810	Environmental Test Methods

2.1.4 Military Publications.-

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment

2.1.3 Federal Publications.-

FED-STD-102	Preservation, Packaging, and Packing Levels
Fed. Reg. vol. 40, No. 148	Department of Health, Education, and Welfare Food and Drug Administration Laser Products/Performance Standards

2.1.6 Other Publications. - The following National Fire Protection Association and American National Standards Institute standards form a part of this specification and are applicable to the extent specified herein.

NFPA-70	National Electrical Code
ANSI X3.4	Code for Information Interchange (ASCII)

(Copies of this specification and other applicable FAA specifications and standards may be obtained from the Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591, Attention: Contracting Officer. Requests should fully identify material desired, i.e., specification, standard, and amendment numbers and dates. Requests should cite the contract number or other use to be made of the requested material.)

(Single copies of the Military specifications and standards may be obtained from Federal Aviation Administration, 800 Independence Ave. S.W., Washington D.C. 20591, Attention: Contracting Officer. Requests should cite the invitation for bids, request for proposals or contract involved. Note that mail requests, if found acceptable, will be forwarded to a Military supply depot for filling; hence, ample time should be allowed).

(Copies of the Federal Standard and the Federal Register, Vol. 40 (7/31/75) pp 32251-32266 may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20401, at the published price.)

(Copies of the National Fire Codes may be obtained from National Fire Protection Association, 470 Atlantic Ave., Boston, Ma. 02210).

(Copies of the ANSI X3.4 standard may be obtained from American National Standards Institute, 1430 Broadway, New York, N. Y. 10018).

3. REQUIREMENTS. -

3.1 Equipment to be furnished by the contractor. - Each CHI system furnished by the contractor shall be complete in accordance with all specification requirements herein.

3.1.1 Digital CHI system. - One complete digital CHI system shall consist of the following;

a.	Transceiver unit	1 ea.
b.	Maintenance unit	1 ea.
c.	Digital Display Unit	1 to 10 ea.

3.1.2 Transceiver unit. - The transceiver shall be mounted in a weather-proof enclosure placed on a supporting stand, collocated with centerfield wind equipment. It shall have an internal power supply which generates a pulsating laser beam through the optical system back to a detector. The laser signal pulses shall be converted into a digital ASCII/FSK signal for transmission to a maintenance unit through a minimum of 10,000 feet of voice grade telephone line. It also shall be capable of receiving and transmitting monitoring signals to a maintenance unit through other signal lines. Data between the transceiver and maintenance unit will be transmitted over multi-paired armored cable procured in accordance with FAA specification FAA-E-2072a/A1. This specification is included for reference purposes only. Other ASCII/FSK coded data and analog data will also be transmitted over this cable. It is a requirement of this specification that the CHI data transmissions not degrade the accuracies of these other transmissions, nor shall the CHI data transmissions be degraded by these other transmissions. The unit shall have self monitoring capabilities to indicate proper operation of its major subsystems as shown by, but not limited to, the following.

a. Laser source
b. Pulse generator
c. Light receiver and detector
d. A/D converter
e. Error Detection Circuitry
f. Self Monitor Circuitry
g. Power supply
h. Data Transmission and Monitor Lines
i. Transceiver enclosure Integrity
j. Environmental controls and systems
k. Range Finding Circuitry

3.1.3 Maintenance unit. - The maintenance unit shall be located in the tower cab equipment room. mounted on a standard panel and chassis (3.3.17.1). It shall have a power supply and all necessary circuitry for conversion of the ASCII/FSK signal into a display, to provide power to the alarm indicators and to transmit the signal to drive up to 10 remote displays, each at the end of a 1000 foot, FAA owned, voice grade telephone cable. The maintenance unit shall also have the capability of transmitting data to displays over, telephone company supplied, standard voice grade telephone circuitry.

It shall have a front mounted display. The maintenance unit shall transmit and receive signals to monitor the major operating parameters of the remotely located transceiver. Monitoring switches and indicators required for the maintenance control and observation of all operation functions within the transceiver shall be mounted on the panel. It shall also monitor and indicate proper operation of its own major subsystems, in addition to those of the transceiver, and shall further indicate status of all interconnecting cabling. The maintenance unit shall be provided with a switch (easily accessible, but not on the front panel) which will convert the system from displaying cloud height information in feet to meters. Provisions shall also be made to automatically indicate on the maintenance unit and display units whether the cloud heights are displayed in feet or meters.

Design of the maintenance unit may be such that the entire unit, or at least the portion containing the self monitoring circuitry and display section, may be removeable and capable of being temporarily connected to the transceiver. With the intent that this portable unit can serve as a means to verify proper operation of the transceiver unit after a maintenance or repair action has been accomplished. A unit designed this way shall be supplied with the necessary hardware and cable, minimum 15 feet, preassembled, to provide power and data cable interconnections between the transceiver and portable unit. The unit shall also be designed to operate under the ambient conditions of environment II of Paragraph 1-3.2.23(b) of FAA-E-2100/1.

3.1.4 Digital display Unit. - The digital display unit located in the tower cab shall display cloud heights of the lowest two levels. Each display unit shall be completely self-contained including AC power supply, AC power cord and signal input connectors or a pigtail signal input with connector in accordance with paragraphs 1-3.6.6, 1-3.6.7 and 1-3.16.3 through 1-3.16.3.6 of FAA-G-2100/1.

3.2 Definitions

3.2.1 Measurement cycle. - The measurement or strobing cycle is the time required to take one measurement by the transceiver unit and convert the data into cloud heights for lowest two layers.

3.2.2 Eye Safety. - An eye safe laser beam is defined as a level of laser radiation which will not cause biological damage to the human eye or other portions of the human body even after extended exposure. This conforms to a Class I laser product under part 1040, Performance Standards for Light Emitting Products, of Section 21, Code of Federal Regulations (See Fed. Reg. Vol 40).

3.2.3. Cloud height. - The cloud height is defined as the elevation in feet or meters from the ground to the base of the cloud layer. It is determined electrically when the density of the cloud becomes great enough to reflect the laser beam back to the detector to a pre-determined value.

3.2.4 American Standard Code for Information Interchange (ASCII) The ASCII code is an 8-bit code (one bit is for parity check) which gives 128 combinations. It is used for both synchronous and non-synchronous teletypewriters and data transmissions.

3.2.5 Frequency-shift Keying (FSK). - A form of frequency modulation in which the modulating wave shifts the output frequency between predetermined values, and the output frequency has no phase discontinuity. The instantaneous frequency is shifted between two discrete values termed mark and space frequencies.

3.3 Design requirements. - The CHI system shall be designed to meet the requirements of the National Electric Code and the following subparagraphs.

3.3.1 Design center-values. - Design center values for this equipment shall be 120v, 60 Hz per 1-3.2.21 of FAA-G-2100/1.

3.3.2 Service conditions. - The equipment shall be designed to operate under service conditions of 1-3.2.23(a) of FAA-G-2100/1. The components shall be designed to operate under the following ambient conditions from 1-3.2.23(b) of FAA-G-2100/1:

(1) Transceiver unit, environment III.

(2) Maintenance unit, environment I.
Portable unit, if supplied, Environment II.

(3) Display unit, environment I.

3.3.3 Error Detection. - Error detection shall be performed by automatically introducing a known input into the laser and processing the signal into a simulated cloud height without actually having it displayed. An error detected in this manner shall be indicated by the letter "E" appearing in place of the most significant digit of both cloud layers being displayed. Error detection shall be performed at one minute intervals just prior to the required display data update time.

3.3.4 Precipitation. - Precipitation on the transceiver in any form such as ice, snow, or rain, etc., shall not degrade operation of the system beyond specification requirements. In addition provisions shall be made to eliminate false targets or clutter generated by precipitation.

3.3.5 Reliability and Maintainability Design Requirements.- The CHI system shall meet the following reliability and maintainability requirements.

MTBF	5000 hrs
MTTR	30 minutes

Where MTBF is the series MTBF which reflects all equipment failures (i.e. failures which result in maintenance action).

The CHI system shall have a Maximum Repair Time (MRT) of 8 hrs (95 percentile) at the shop level, where shop level is repair (or other final disposition) of the removed malfunctioning card, module or replacable unit at the cognizant facility.

3.3.5.1 Reliability Program

3.3.5.1.1 Reliability Program Plan.- The contractor shall prepare and submit within the technical proposal a reliability program plan. The reliability program plan shall delineate how the requirements of the request for proposal and the statement of work will be met. The plan shall be in accordance with paragraph 1-3.19 of FAA-G-2100/1b and paragraph 4.4 of MIL-STD-785A as modified below.

3.3.5.1.2 Reliability Management.- Reliability Management shall be in accordance with paragraph 1-3.19 of FAA-G-2100/1b and paragraphs 5.1.1, 5.1.3 and 5.1.4 of MIL-STD-785A.

3.3.5.1.3 Reliability Design and Evaluation.- Reliability design and evaluation shall be in accordance with paragraphs 5.2.1, 5.2.2 and all subparagraphs, 5.2.3, 5.2.5 and 5.2.7 of MIL-STD-785A and paragraph 3.3.5.1.3.1 of this specification.

3.3.5.1.3.1 Failure Mode, Effects, and Criticality Analysis.- A FMECA based on all system functional requirements shall be initiated as an integral part of the design process and shall periodically be updated to reflect design changes. The FMECA shall be conducted down to the level of repair in normal maintenance for the equipment comtemplated. For each replaceable element, the applicable modes of failure shall be injected into the analysis to ascertain areas of criticality based upon failures and their levels of expectancy (i.e., failure rates). The results of the FMECA shall be used to evaluate the model, determine areas of criticality, and if needed, determine appropriate design changes. Particular attention shall be paid to redundant equipment applications to assure that the redundancy is not invalidated by obscure circuit effects or sneak paths. Contractor reliability engineers shall work with design personnel on a continuing basis in completing the following tasks:

a) Identify system, subsystem, and component failure modes

b) Identify probable causes of failures

c) Identify failure symptoms

d) Identify effects of failures on system functions/operations

e) Determine failure mode rate

f) Recommend appropriate corrective features such as redundancy failsafe design, backups, and selection of more reliable parts

g) Assist in the formulation of test criteria selected in light of identified critical failure modes

The FMECA report shall include a summary discussion of all the tasks listed above. A preliminary FMECA shall be presented prior to the preliminary design review and updated periodically to reflect design changes.

3.3.5.1.4 Failure Data Collection, Analysis and Corrective Action.- Failure data collection, analysis and corrective action shall be in accordance with MIL-STD-785A paragraph 5.4.1.

3.3.5.1.4.1 Failure Summaries.- Weekly summaries of failures shall be sumbitted during all phases of testing. They shall include identification of each failure analysis report, equipment failure mode, cause of faiulre, and corrective action recommended. The summaries shall be reported such that trends, patterns, etc. can be discerned.

3.3.5.1.5 Reliability Status Reports.- The contractor shall prepare and submit monthly reliability program status reports in accordance with paragraph 5.6 of MIL-STD-785A.

3.3.5.2 Maintainability Program.-

3.3.5.2.1 Maintainability Program Plan.- The contractor shall prepare and submit for approval a maintainability program plan. The program plan shall be in accordance with paragraph 1-3.20 of FAA-G-2100/1b and paragraph 5.1 of MIL-STD-470.

3.3.5.2.2 Maintainability Analysis.- A maintainability analysis of the CHI system shall be accomplished in accordance with paragraph 5.2 of MIL-STD-470.

3.3.5.2.3 Maintenance Concept and Plan.- A detailed maintenance concept and plan shall be prepared in accordance with MIL-STD-470 paragraph 5.3.

3.3.5.2.4 Maintainability Design Criteria.- Maintainability design criteria shall be established in accordance with paragraph 5.4 of MIL-STD-470 and the following:

a) Preventive maintenance - components shall be chosen that require little or no preventive maintenance. Preventive maintenance requirements shall be determined and the schedule, procedure, and the estimated duration of each preventive maintenance task shall be reported as part of the maintainability prediction results.

b) Monitoring, Built-in Test (BIT) and Fault Isolation (FIT) - If the maintenance design concept demands a built-in capability to sence, identify, and locate failures in order to achieve the required level of maintainability, the following requirements shall be applied in the establishment of design criteria:

1) Failsafe requirements - BIT/FIT shall be designed to have a failure rate not exceeding 10% of that of the equipment being monitored. In the event of a failure in the BIT/FIT equipment, that equipment shall automatically display its failed state and shall not induce a failure in the function being monitored.

2) BIT requirements - BIT circuitry shall be 95% effective in detecting the failed component and identifying failures in the functional loop for which it is designed. The achievement of BIT effectiveness shall be demonstrated.

3) FIT requirements - FIT circuitry shall be 95% effective in isolating to a replaceable assembly (module). The achievement of FIT effectiveness shall be demonstrated.

4) False alarm rate requirements - FIT and BIT circuitry shall be designed to prevent the occurrence of system failure. The maximum permissable false alarm rate shall be 1%.

3.3.4.2.5 Design Tradeoff Tasks.- Design tradeoffs and documentation of tradeoffs shall be in accordance with paragraph 5.5 of MIL-STD-470. As a minimum, tradeoff studies shall include the following:

a) BIT/FIT effectiveness vs. acquisition cost

b) BIT/FIT effectiveness vs. logistic support costs

c) Modularity implementation vs. MTTR improvement

d) Throw away vs. repairability of modules

3.3.5.2.6 Maintainability Predictions.- Maintainability predictions shall be prepared in accordance with paragraph 5.6 of MIL-STD-470 and the following:

Preliminary prediction shall be prepared and included in the maintainability program plan submitted with the technical proposal. These pedictions shall be updated to reflect the effects of any design changes on system MTTR and also to include additional data obtained during design. Final predictions shall be submitted to the FAA at least 45 days prior to the initiation of the maintainability demonstration test. The following predicution techniques shall be implemented by the contractor:

3.3.5.2.6.1 Early Design Predictions.- During the early design and development stages prediction of mean corrective maintenance time shall be prepared and performed in accordance with procedure III of MIL-HDBK-472.

3.3.5.2.6.2 Final Design Predictions.- During the final design stages of development predictions of mean corrective maintenance time shall be in accordance with procedure II of MIL-HDBK-472.

3.3.5.2.7 Design Review Task.- The contractor shall conduct maintainability design reviews in accordance with paragraph 5.9 of MIL-STD-470 and the following.

The planned maintainability design reviews shall include the following:

a) Current maintainability estimates and achievements as derived from predictions, analyses or tests.

b) Status and description of the maintainability program plan

c) Results of optimum repair level analysis

d) Effects of engineering decisions, changes, and tradeoffs upon maintainability achievements, potential and growth

e) Status of subcontractor and vendor maintainability programs

f) Functioning of maintainability data collection systems

g) Review of problems and any unresolved issues.

3.3.5.2.8 Maintainability Status Reports.- The contractor shall prepare and submit monthly maintainability status reports in accordance with paragraph 5.12 of MIL-STD-470 per documentation requirements.

3.3.6 Equipment Maintenance.- Equipment design shall be such that all maintenance required to maintain system operation within specification limits can be performed with the use of standard test equipment and tools available to FAA Electronic Technicians. FAA Order 6200.4B Test Equipment Management Handbook, lists the standard equipment available at FAA facilities, and FAA Order 4630.2, Standard Allowance of Supplies and Working Equipment for NAS Facilities, lists tools that are available at FAA facilities. This shall include any equipment or tools necessary to verify proper operation of the system after a maintenance or repair action has been accomplished. If any special tools or equipment are required to perform the above functions it will be the contractors responsibility to supply them. In addition a list of said tools and equipment shall be provided to the contracting officer coincendental with the submission of the provisioning parts list.

3.3.7 Instruction Manuals. - Instruction manuals shall be supplied in accordance with the applicable paragraphs of FAA-D-2494/1a and 2a. The manual plans shall be submitted as specified in the invitation for bids.

3.3.8 Interchangeability. - Any system component shall be interchangeable with any other system component of the same type as specified in 1-3.14.3 of FAA-G-2100/1. Any system shall remain within specification limits when any system component is interchanged with any corresponding component from another system.

3.3.9 Solid State Circuitry. - No vacuum tubes shall be used in the system. Solid state circuitry shall be used throughout. Printed wiring boards shall be employed in accordance with Specification FAA-G-2100/1, FAA-G-2100/3 and FAA-G-2100/4.

3.3.10 Integrated Circuitry. - Only integrated circuits available as a standard catalog item from two or more manufacturers shall be employed. The circuits shall meet the requirements of FAA-G-2100/4. Plastic encapsulated circuits may be employed only with prior FAA approval.

3.3.11 System Warm-up time. - System shall be fully operational per specifications within a period not to exceed 15 minutes from the time of application of AC power.

3.3.12 Cloud height range and accuracy. - The CHI shall have a range of 100 - 10,000 feet (30-3000 meters). The system shall display cloud height in 100 foot (30 meter) increments with an accuracy of ± 50 feet (± 15 meters) over the range 100 - 5,000 feet (30 - 1500 meters). From 5,500 - 10,000 feet (1650 - 3000 meters) the system shall display cloud height in 500 foot (150 meter) increments with an accuracy of ± 250 feet (± 75 meters). Compliance with this requirement shall be demonstrated under atmospheric conditions of good visibility and no precipitation. For the purposes of this specification good visibility is considered to exist when a transmissometer located in the vicinity of the cloud height indicator reports a visual range of 6,000 feet or better under day time conditions looking at a dark object against a light background.

3.3.13 Display. - The height of the two lowest cloud layers shall be displayed, one over the other, the lower being the lower cloud level. The display shall be updated at one minute intervals. The table below shows the expected displays under varying situations.

	Situations	Lower Value	Upper Value
(1)	Two cloud layers	Actual	Actual
(2)	One cloud layer (laser does not penetrate lower cloud base)	Actual	UNM*
(3)	One cloud layer (laser penetrates cloud base but no significant second layer)	Actual	UNM*
(4)	No clouds	UNM*	UNM*

*NOTE: The numerics "UNM" (UNMEASURED) shall be displayed as the last three significant digits.

3.3.13.1 Legibility. - The displays shall be clearly legible when viewed in broad daylight, installed in a tower console. The brightness of the display shall be adjustable so that the numbers are discernible at ten feet with the ambient lighting on the display varying from moonlight (0.01 foot candle) to shaft sunlight (10,000 foot candles).

3.3.14 Connectors. - All connectors shall be furnished in accordance with FAA-G-2100/1 paragraphs 1-3.16.3 through 1-3.16.3.7 and 1-3.6.6 and shall be of the positive - lock type. Mating connectors shall be furnished.

3.3.15 System performance requirements. - The requirements of the following subparagraphs are applicable to the overall system.

3.3.15.1 Self monitoring. - The system shall have a self monitoring capability of the following system components.

Laser source
Light detector and receiver
A/D converter
Error detection circuitry
Self monitoring components
Power supply
Data transmission and monitor lines
Transceiver enclosure integrity
Environmental controls and systems
Digital displays
Range Finding Circuitry

If an error is detected the self monitor shall inhibit the display of the incorrect data and display the letter "E" as the most significant digit of all displays. Self monitoring shall be performed at least once each minute.

3.3.15.2 Maintenance display. - During a maintenance evaluation of the system at the maintenance or transceiver units, a "C" shall be displayed at all displays in place of the most significant digit. This display may be enabled by the use of a switch at the maintenance unit.

3.3.15.3 Data Transmission. - The transceiver shall process the cloud height elevation into serialized signal outputs, control characters and message identification. The operating frequency shall be 1270/1070 Hz at a rate of 300 baud. The signal output shall operate into a normal 600 ohm telephone line load. The data transmission shall be not less than once each minute; the least significant digit shall be transmitted first.

3.3.15.4 Lightning Protection. - The table below lists the standard Government furnished lightning and surge protection devices available for protection on land lines. It will be the contractor's responsibility to identify which of these devices will be required to protect his equipment. If the contractor's equipment design is such that one of the devices listed below will not provide the necessary protection, it will be the contractor's responsibility to provide similar devices for protection of its equipment on both ends of all land lines.

CIRCUIT TYPE	NOMINAL LINE VOLTAGE	MAXIMUM CLAMPING VOLTAGE (VOLTS)
PA1-1	115 VAC	650.0
PA1-2	400 VDC	650.0
PA3-1	+ 28 VDC	61.9
PA3-2	± 60 VDC	± 118.0
PA3-3	∓ 5 VDC	− 10.8
	100 MVAC	
PA3-4	+ 12 VDC	26.5
PA3-5	36 VAC	80.5
PA3-6	+ 18 VDC	43.5
PA3-7	± 8 VDC	± 17.3
PA3-8	− 115 VAC	− 287.0
PA3-9	+ 48 VDC	92.0
PA3-10	+ 15 VDC	31.9

CIRCUIT TYPE	NOMINAL LINE VOLTAGE	MAXIMUM CLAMPING VOLTAGE (VOLTS)
PA3-12	+ 5 VDC 100 MVAC	10.8
PA3-13	- 12 VDC	- 26.5
PA3-14	28 VAC	61.9
PA3-15	+ 6 VDC	10.0
PA4-1	+ 28 VDC	63.8
PA5-2	+ 28 VDC	61.9
PA5-3	28 VAC	61.9
PA5-4	10 VAC	26.5
PA5-5	+ 18 VDC	43.5
PA5-6	+ 12 VDC	26.5
PA5-7	+ 28 VDC	61.9
PA5-9	36 VAC	80.5
PA5-10	+ 28 VDC	61.9
PA5-11	+ 8 VDC	14.5
PA5-12	+ 48 VDC	92.0
PA5-13	+ 22 VDC	53.0
PA5-14	+ 6 VDC	12.5

3.3.15.5 Finish. - In order to provide reduced solar energy pickup as well as reduced internal temperatures within the transceiver both internal and external finishes shall be selected to satisfy this requirement. If other than standard finishes of section 1-3.8 and subparagraphs of FAA-G-2100/1 are desired, Government approval in writing shall be obtained prior to use.

3.3.15.6 Nameplates. - Nameplates shall be provided in accordance with paragraph 1-3.13 and subsequent subparagraphs of FAA-G-2100/1. Equipment title shall be coordinated with the Contracting Officer.

3.3.16 Transceiver. - The transceiver shall be a laser system and shall meet the Class I Eye Safety requirements as defined in paragraph 3.2.2 herein.

3.3.16.1 Housing. - The transceiver shall be of waterproof construction in aluminum alloy of sufficient weight so constructed as to form a firm and permanent support for the optical and electrical system therein. The transceiver unit shall not be more than 15 cubic feet nor weigh more than 300 pounds (not including the stand). A carrying bar or handles shall be installed on each end of the housing. No error in internal optical alignment due to mounting or handling shall occur. Access for maintenance shall be provided as necessary via gasketed environment proof panels or doors. The design of the housing shall be such that the system and its support stand can withstand the rain and salt fog environments of paragraph 4.3.3.3 without degradation beyond specification limits.

3.3.16.2 Supporting Stand. - A stand shall be provided to mount the transceiver housing. The stand shall be an assembly of metal (angles, pipe or other structual shapes), with feet or flanges for anchoring to a foundation. The transceiver shall be mounted not less than 30 inches above the ground. The stand shall support double the weight of the transceiver and be crossbraced to provide a rigid structure.

3.3.16.3 Connectors. - All external connectors and mating connectors shall conform with FAA-G-2100/1 paragraph 1-3.16.3.1 and shall be of a waterproof positive locking type.

3.3.16.4 Environmental Controls. - Equipment to control deposits of rain, snow ice, etc., such as heaters, blowers, or other types of conditioners shall be incorporated to permit conformance with 3.3.4 herein.

3.3.16.5 Optics. - The optics shall consist of a laser light source with the light collimated into a beam. The beam shall be transmitted vertically. The detector shall be collocated in the same housing as the laser and shall be optically aligned to receive the greatest amount of the reflected light from the cloud base(s). The optics shall be factory aligned in a rigid position so that field adjustments are unnecessary.

3.3.16.6 Power. - The power input of the transceiver shall not exceed 150 watts with an additional 500 watts for the environmental components.

3.3.17 Maintenance unit. - The maintenance unit shall provide all functions listed in paragraph 3.1.3 herein.

3.3.17.1 Housing. - The maintenance unit shall be designed for 19" relay rack panel conforming to drawing D-21140 and 3.9, 3.9.1 and 3.9.2 of FAA-G-2300.

3.3.17.2 Cabling. - The signals between the maintenance unit and the transceiver shall be capable for transmission not less than 10,000 feet via standard 600 ohm telephone lines.

3.3.17.3 Signal input. - The signal from the transceiver to the maintenance unit shall be ASCII coded FSK for the display. The control and monitor circuits shall be low voltage type for signal type cables.

3.3.17.4 Indicator lamps. - Lamps shall be provided on the front panel of the maintenance unit to indicate errors detected by the self monitoring circuits of paragraph 3.1.2, 3.1.3 and 3.3.15.1 herein. A different lamp shall be provided for each monitoring circuit. Provisions shall be made for a test switch, which, when depressed, will light all the indicator lamps.

3.3.17.5 Power requirements. - The power required at the maintenance unit shall not exceed 150 watts.

3.3.17.6 Local maintenance display. - The display of cloud height on the maintenance unit shall be identical with that provided in the digital display unit. Provisions shall be made for a test switch, which, when depressed, will light all display segments. This switch may, at the option of the contractor, provide the test function of this paragraph as well as for paragraph 3.3.17.4 herein.

3.3.18 Digital display unit. - The digital display unit shall be designed to provide operation in accordance with paragraph 3.1.4 herein.

3.3.18.1 Display. - The dual level cloud height display shall be all solid state electronic and consist of two rows of five individual digit, segment-type numeric displays. The height of each character shall be no less than 0.3 inches, the width of each character shall be no less than 0.2 inches and the space between charactors shall not exceed 1 1/2 times the height. The viewing angle as measured from the face of the display shall be no less than 60 degrees from the perpendicular in both the vertical and horizontal axes of the display. All digits shall have the capability of displaying the letters C, E, M, N and U, as well as numerals. The intensity of the display shall be adjustable such that the readout can be discerned from its background at a distance of 10 feet under ambient illumination conditions varying from 0.01 to 10,000 foot candles.

3.3.18.1.1 Intensity control. - An intensity control shall be furnished which shall provide brillance control from 100% to 5% or less.

3.3.18.2 Housing. - The digital display unit shall be designed so that it will mount on a face plate no larger than 4-1/2 inches square and recess no deeper than 8 inches through a 3-1/2 inch square hole for flush surface mounting. Mounted on the front panel should be at least:

a. Two five digit displays

b. A power on-off switch and a display intensity control.

c. A push button type test switch which, when depressed, will light all segments of the display.

The rear of the unit shall be equipped with a power input connector or pigtail and connector and a signal input connector. Mounting holes 0.173" dia. shall be centered at each corner of the face plate.

3.3.19 Extender Boards. - The contractor shall provide an extender board for each different size plug-in printed circuit board in the CHI system. Space shall be provided within the equipment for storage of the extender board(s) when they are not in use.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control provision. - The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013. All tests and inspections made by the contractor shall be subject to Government inspection. The term "Government inspection", as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspections as deemed necessary to assure compliance with contract requirements. Tests shall be conducted at the Contractor's plant or test facility and at the Contractors expense. All test facilities instrumentation connection and personnel necessary to conduct the tests required by this specification shall be furnished by the Contractor.

4.1.1 Classification of Tests. - Six classes of tests are required to be accomplished on the Cloud Height Indicator as follows:

Preliminary Tests
Design Qualification Tests
Type Tests
Production Tests
Reliability Demonstration Test
Maintainability Demonstration Test

4.1.2 Test procedures. - The contractor shall submit to the contracting officer at least, 60 days in advance of the proposed dates of the first test, test plans showing the procedures for all classes of tests specified including samples of the data sheets to be used for recording the results.

4.2 Contractor's preliminary tests. - Prior to the time the contractor notifies the Government that the initial production system is ready for inspection, and to demonstrate readiness for inspection, he shall make one complete set of all tests required by this specification excluding reliability and maintainability tests. These preliminary tests shall be made on one production system or on one prototype (preproduction) model. The contractor's preliminary tests do not constitute any of the regular design qualification tests, type tests, or production tests required by the equipment specification or by the referenced general specifications.

4.2.1 Preliminary test data. - The contractor shall submit to the Government contracting Officer a certified copy of the test data covering all the contractor's preliminary tests. This test data may be submitted along with the proposed test procedures and forms under FAA-STD-013, but, in any case, the test data shall be submitted not less than 10 working days in advance of the date set for inspection pursuant to paragraph 4.2.2.

4.2.2 Notification of readiness for inspection. - After a submission of the preliminary test data, and when the contractor has one or more production systems completed, i.e., equipments produced to meet all specification requirements, he shall notify the Government Contracting Officer in writing that he is ready for Government inspection. Such notification shall be given in time to reach the Contracting Officer not less than five work days before the contractor desires inspection to start.

4.3 Design qualification tests. - The following tests (and verification) shall be made on a regular production system selected by the FAA representative.

Rating verification of parts and materials (4.3.1)

Other general specification tests (4.3.2)

Other design qualification tests in this specification (4.3.3 - 4.3.3.2)

4.3.1 Rating verification of parts and materials. - Measurements or calculations, or both, shall be made in order to establish that the electrical and electro-mechanical parts, wire and insulating materials used in the equipment will not be subjected to voltage, currents, power dissipation, and temperature in excess of the derated values permitted by applicable specification requirements.

The following is a basic list of parts and materials to which the foregoing applies, other electrical and electro-mechanical parts used in the system shall also be subject to the foregoing.

Capacitors	Relays	Connectors
Crystals	Resistors	Semiconductor Devices
Fuses	Switches	(Transistors, Rectifiers
Insulators	Transformers	Diodes, Displays, etc.)
Insulating Materials	Wire	
Motors		

4.3.2 Other general specification tests. - Tests shall be made in order to establish that the requirements of the following paragraphs of FAA-G-2100/1 wherever applicable, are being met:

Discharge of capacitors 1-3.5.5
Ground potentials 1-3.5.9.2 to 1-3.5.9.3
AC line input resistance to ground (service conditions of temperature and humidity) 1-3.6.3
Circuit protection (at minimum line voltage in service conditions range) 1-3.7
Performance requirements and tolerances specified in parts 3,4 and 5 of FAA-G-2100 where such parts are applicable.

4.3.3 Other design qualification tests. - Tests, calculations and or inspections shall be made to establish conformance with specification requirements as listed in Table I under Design Qualification Tests. The system to be used in the performance of these tests shall consist of a transceiver unit, a maintenance unit, and 10 digital display units. In lieu of the use of 10 displays 2 displays may be used with an equivalent load for the remaining 8 displays. For purposes of these tests the transceiver shall be connected to the maintenance unit through 10,000 feet of voice grade telephone line. At least one display shall be connected to the

maintenance unit through voice grade telephone company equipment with the remaining displays connected through 1000 feet of voice grade telephone line.

4.3.3.1 Design qualification tests under service conditions. - A complete set of tests to establish conformance with specification requirements as listed in Table I under Design Qualification Tests, Service Conditions shall be performed on the system as defined in paragraph 4.3.3. above. These tests shall be performed under the conditions below. Equipment shall be on for a minimum of 15 minutes during each test condition.

1.	AC line voltage (all equipment		102V
	AC line frequency (all equipment)		57Hz
	Temperature (all equipment)	nominal	25° C
	Relative Humidity (all equipment)	nominal	50 %
2.	AC line voltage (all equipment)		138V
	AC line frequency (all equipment)		63Hz
	Temperature (all equipment)	nominal	25° C
	Relative Humidity (all equipment)	nominal	50%
3.	AC line voltage (all equipment)	nonimal	120V
	AC line frequency (all equipment)	nominal	60Hz
	Temperature (Transceiver)		-50° C
	Temperature (Maintenance and Display Panels)		+10° C
	Relative Humidity (all equipment)	nominal	50%
4.	AC line voltage (all equipment)	nominal	120V
	AC line frequency (all equipment)	nominal	60Hz
	Temperature (Transceiver)		+70° C
	Temperature (Maintenance and display panels)		+50° C
	Relative humidity (Transceiver)		100%
	Relative humidity (Maintenance and display panels)		80%

NOTE: Equipment shall be stabilized at the temperatures of condition (3) and at the temperatures and relative humidities of condition (4) for a minimum of one hour.

4.3.3.2 Design qualification tests under special environmental conditions. - A complete set of tests to establish conformance with specification requirements as listed in Table I under Special Environmental Tests shall be performed before and after each of the environmental tests are made unless otherwise specified. The system to be tested to the specification requirements shall be as defined in paragraph 4.3.3 above. The environmental tests themselves will only be performed on the transceiver portion of the system. The following lists the environmental tests to be performed.

1. Wind and Ice loading in accordance with paragraph 1-4.10 of FAA-G-2100/1b.

2. Rain tests in accordance with Mil-STD-810c, Method 506.1, Procedure I.

   NOTE: In addition to performing specification tests before and after the rain test the system shall be tested to establish conformance to specification requirements as listed in Table I during the last 10 minutes of each 30 minute rain.

3. Salt fog tests in accordance with MIL-STD-810c. Method 509.1, Procedure I.

   NOTE: In addition to performing specification tests before and after the salt fog test the system shall be tested to establish conformance to specification requirements as listed in Table I after the 48 hour drying period.

4.4 Type tests. - A complete set of tests, to establish conformance with specification requirements as listed in Table I, under Type tests, shall be performed in accordance with paragraphs 1-4.3.3 thru 1-4.3.3.2 of FAA-G-2100/1. For purposes of this paragraph the systems to be tested shall be as defined in paragraph 4.3.3 above. The tests shall be performed at service conditions as specified in paragraph 3.3.2 herein.

4.5 Production tests. - A complete set of tests shall be performed at normal test conditions on each completed system including those subjected to type tests to establish conformance with specification requirements as listed in Table I under Production tests. The system configuration to be tested shall be as defined in paragraph 4.3.3 above.

4.6 Reliability demonstration tests. - A reliability demonstration shall be performed using one or more production systems as defined in paragraph 4.3.3 above, in accordance with the contractor's approved test plan. Tests shall be made to establish conformance with specification requirements as listed in Table I, under reliability tests. The specified mean time between failures (MTBF) is 5000 hours. This MTBF shall be demonstrated utilizing test level A-1, except as noted below, test plan IV of MIL-STD-781B. A failure is defined as any equipment or component failure that prevents accurate display of cloud height on the digital display units. The test shall be conducted continuously with no allowable repairs or shutdowns.

NOTE: The system shall be tested in accordance with test level A-1 except that the transceiver unit shall be temperature cycled for a minimum of 1000 hours. The temperature range shall be as specified in paragraph 3.3.2 herein.

4.7 Maintainability demonstration test. - A maintainability demonstration shall be performed on a production system to demonstrate the requirements of paragraph 3.3.6. The demonstration shall be performed in accordance with test method 4 of MIL-STD-471. The MTTR shall be 30 minutes and the maximum corrective maintenance downtime shall be 2 hours.

5. PREPARATION FOR DELIVERY

5.1 General. - Preservation, packaging and packing, and marking shall be in accordance with the requirements of Specification MIL-E-17555. Levels of protection as defined in FED-STD-102 shall be as specified by the procuring activity.

5.2 Preservation and packaging. - Each master unit complete with two sets of instruction books, shall be individually preserved and packaged in accordance with the Level C requirements of Specification MIL-E-17555. Each remote display unit shall be individually preserved and packaged at the specified level. Each packaged unit shall be individually marked for identification and stocking.

5.3 Packing. - Items preserved and packaged as above, shall be packed in exterior type containers, selected from appropriate tables of MIL-E-17555, conforming to the applicable levels of packing specified. The shipping containers shall be marked in accordance wiht the procurement documents.

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TABLE I

PARAGRAPH	DESIGN QUALIFICATION TESTS	DESIGN QUALIFICATION TESTS SERVICE CONDITIONS	SPECIAL ENVIRONMENTAL TESTS	TYPES TESTS	PRODUCTION TESTS	RELIABILITY TESTS
3.1.2	X					
3.1.3	X	X	X	X	X	X
3.3.1	X					
3.3.2		X		X		
3.3.3	X	X	X	X	X	X
3.3.4			X	X		
3.3.5						X
3.3.6	X					
3.3.8	X					
3.3.9	X					
3.3.10	X					
3.3.11	X	X	X	X	X	X
3.3.12	X	X	X	X	X	X
3.3.13	X				X	
3.3.13.1	X					
3.3.14	X					
3.3.15.1	X	X	X	X	X	X
3.3.15.2	X				X	X
3.3.15.3	X			X	X	X
3.3.15.4	X					
3.3.15.5	X					
3.3.15.6	X					
3.3.16	X					
3.3.16.1	X	X	X	X		
3.3.16.2	X					
3.3.16.3	X					
3.3.16.4		X	X	X		
3.3.16.5	X					
3.3.16.6	X	X	X			
3.3.17.1	X					
3.3.17.3	X					
3.3.17.4	X			X	X	X
3.3.17.6	X			X	X	X
3.3.18.1	X				X	
3.3.18.1.1	X				X	
3.3.18.2	X				X	